

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 12 February 2001 (12.02.01)	
International application No. PCT/IB00/00725	Applicant's or agent's file reference 02445PC
International filing date (day/month/year) 29 May 2000 (29.05.00)	Priority date (day/month/year) 25 June 1999 (25.06.99)
Applicant TRETIAKOV, Vjatcheslav et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
20 November 2000 (20.11.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Olivia TEFY Telephone No.: (41-22) 338.83.38
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The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ EP

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only	
Identification of IPEA	Date of receipt of DEMAND
Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION	
Applicant's or agent's file reference 02445PC	
International application No. PCT/IB00/00725	International filing date (day/month/year) (29/05/00) 29 May 2000
(Earliest) Priority date (day/month/year) (25/06/99) 25 June 2000	
Title of invention Digital x-ray scanning apparatus	
Box No. II APPLICANT(S)	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) DDI Direct Digital Imaging GmbH Seidenhofstrasse 14 CH-6003 Luzern Switzerland	
Telephone No.:	
Facsimile No.:	
Teleprinter No.:	
State (that is, country) of nationality: CH	State (that is, country) of residence: CH
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) TRETIAKOV Vjatcheslav Ivanova Street 30 A, apt. 122 RU-630117 Novosibirsk Russia	
State (that is, country) of nationality: RU	State (that is, country) of residence: RU
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) SKOK Andrei Sirenevaja Street 23, apt. 32 RU-630058 Novosibirsk Russia	
State (that is, country) of nationality: RU	State (that is, country) of residence: RU
<input checked="" type="checkbox"/> Further applicants are indicated on a continuation sheet.	

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet should not be included in the demand.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

PORTMANN Markus
Mattmannhof
CH-6034 Inwil
Switzerland

State (that is, country) of nationality:

CH

State (that is, country) of residence:

CH

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

GEISSER Albert
Nasmannsbach 8
CH-6373 Ennetbürgen
Switzerland

State (that is, country) of nationality:

CH

State (that is, country) of residence:

CH

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

State (that is, country) of nationality:

State (that is, country) of residence:

☐ Further applicants are indicated on another continuation sheet.

Box N . III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCEThe following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.Name and address: *(Family name followed by given name; for a legal entity, full official designation.
The address must include postal code and name of country.)*E. Blum & Co.
Vorderberg 11
CH-8044 Zürich
Switzerland

Telephone No.:

0041 1 261 54 54

Facsimile No.:

0041 1 251 67 17

Teleprinter No.:

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:***

1. The applicant wishes the international preliminary examination to start on the basis of:

☒ the international application as originally filedthe description ☐ as originally filed
☐ as amended under Article 34the claims ☐ as originally filed
☐ as amended under Article 19 (together with any accompanying statement)
☐ as amended under Article 34the drawings ☐ as originally filed
☐ as amended under Article 342. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English

☒ which is the language in which the international application was filed.☐ which is the language of a translation furnished for the purposes of international search.☐ which is the language of publication of the international application.☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.**Box No. V ELECTION OF STATES**

The applicant hereby elects all eligible States (that is, all States which have been designated and which are bound by Chapter II of the PCT)

excluding the following States which the applicant wishes not to elect:

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- | | | |
|--|---|--------|
| 1. translation of international application | : | sheets |
| 2. amendments under Article 34 | : | sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4. copy (or, where required, translation) of statement under Article 19 | : | sheets |
| 5. letter | : | sheets |
| 6. other (specify) | : | sheets |

For International Preliminary Examining Authority use only

received not received

<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

The demand is also accompanied by the item(s) marked below:

- | | |
|--|---|
| 1. <input checked="" type="checkbox"/> fee calculation sheet | 4. <input type="checkbox"/> statement explaining lack of signature |
| 2. <input type="checkbox"/> separate signed power of attorney | 5. <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6. <input type="checkbox"/> other (specify): |

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

E. Blum & Co.
i.V.

Zürich, 17 November 2000 rw

Rainer Schalch (RA)

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply.

☐ The applicant has been informed accordingly.

4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.

5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum)

02445PC

Box No. I TITLE OF INVENTION

Digital X-Ray Scanning Apparatus

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

DDI Direct Digital Imaging GmbH
Neustadtstrasse 8
CH-6003 Luzern
Switzerland

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State (that is, country) of nationality:

CH

State (that is, country) of residence:

CH

This person is applicant for the purposes of:

☐ all designated States

☒ all designated States except the United States of America

☐ the United States of America only

☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

TRETIKOV Vjatcheslav
Ivanova Street 30 A, apt. 122
RU-630117 Novosibirsk
Russia

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

RU

State (that is, country) of residence:

RU

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☒ the United States of America only

☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

E. Blum & Co.
Vorderberg 11
CH-8044 Zürich
Switzerland

Telephone No.

01/261 54 54

Facsimile No.

01/251 67 17

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

SKOK Andrei
Sirenevaja Street 23, apt. 32
RU-630058 Novosibirsk
Russia

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

RU

State (that is, country) of residence:

RU

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☒ the United States of America only

☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

PORTMANN Markus
Mattmannhof
CH-6034 Inwil
Switzerland

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

CH

State (that is, country) of residence:

CH

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☒ the United States of America only

☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

GEISSER Albert
Nasmannsbach 8
CH-6373 Ennetbürgen
Switzerland

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

CH

State (that is, country) of residence:

CH

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☒ the United States of America only

☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☐ the United States of America only

☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☒ **AP** ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA** Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP** European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA** OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|---|---|
| <input checked="" type="checkbox"/> AE United Arab Emirates | <input checked="" type="checkbox"/> LR Liberia |
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> LS Lesotho |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> LT Lithuania |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> LU Luxembourg |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> LV Latvia |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> MA Morocco |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> MD Republic of Moldova |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> MG Madagascar |
| <input checked="" type="checkbox"/> BG Bulgaria | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BR Brazil | <input checked="" type="checkbox"/> MN Mongolia |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> MW Malawi |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> MX Mexico |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> NO Norway |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> CR Costa Rica | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> DM Dominica | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> GE Georgia | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> GH Ghana | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> TZ United Republic of Tanzania |
| <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> IN India | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> IS Iceland | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> JP Japan | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> KE Kenya | <input checked="" type="checkbox"/> ZA South Africa |
| <input checked="" type="checkbox"/> KG Kyrgyzstan | <input checked="" type="checkbox"/> ZW Zimbabwe |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | |
| <input checked="" type="checkbox"/> KR Republic of Korea | |
| <input checked="" type="checkbox"/> KZ Kazakhstan | |
| <input checked="" type="checkbox"/> LC Saint Lucia | |
| <input checked="" type="checkbox"/> LK Sri Lanka | |

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- ☒ **DZ** Algeria
- ☒ **AG** Antigua and Barbuda
- ☒ **MZ** Mozambique

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)

Box No. VI PRIORITY CLAIM		<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.		
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application:* regional Office	international application: receiving Office
item (1) (25.06.99) 25 June 1999	99 112 248.2		EP	
item (2)				
item (3)				

☐ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s):

* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY		
Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used): ISA / EP	Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority): Date (day/month/year) Number Country (or regional Office)	

Box No. VIII CHECK LIST; LANGUAGE OF FILING	
This international application contains the following number of sheets: request : 4 description (excluding sequence listing part) : 18 claims : 7 abstract : 1 drawings : 7 sequence listing part of description : 0 Total number of sheets : 37	This international application is accompanied by the item(s) marked below: 1. <input checked="" type="checkbox"/> fee calculation sheet 2. <input type="checkbox"/> separate signed power of attorney 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: 4. <input type="checkbox"/> statement explaining lack of signature 5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s): 6. <input type="checkbox"/> translation of international application into (language): 7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material 8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form 9. <input type="checkbox"/> other (specify):
Figure of the drawings which should accompany the abstract: 1	Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT	
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).	
E. Blum & Co. i.V. R. Schalch	Zurich, 26 May 2000 cp

For receiving Office use only	
1. Date of actual receipt of the purported international application:	2. Drawings: <input type="checkbox"/> received: <input type="checkbox"/> not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
5. International Searching Authority (if two or more are competent): ISA /	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.

For International Bureau use only
Date of receipt of the record copy by the International Bureau:

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

E. BLUM & Co.
Vorderberg 11
8044 ZÜRICH
SUISSE

25. JULI 2001					
LPA	NF	MR	IN	Ch	A
2			1		
1		25.7			
2		3.8			

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing
(day/month/year)

23.07.2001 **2308**

Applicant's or agent's file reference

02445PC

REPLY DUE

within 1 month(s)
from the above date of mailing

International application No.

PCT/IB00/00725

International filing date (day/month/year)

29/05/2000

Priority date (day/month/year)

25/06/1999

International Patent Classification (IPC) or both national classification and IPC

A61B6/00

Applicant

DDI DIRECT DIGITAL IMAGING GMBH et al.

1. This written opinion is the first drawn up by this International Preliminary Examining Authority.
2. This opinion contains indications relating to the following items:
 - I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☐ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain document cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application
3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.
4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 25/10/2001.

Name and mailing address of the international preliminary examining authority:



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner

Sonntag, A

Formalities officer (incl. extension of time limits)

Marra, E

Telephone No. +49 89 2399 7235



WRITTEN OPINION

International application No. PCT/IB00/00725

I. Basis of the opinion

1. With regard to the elements of the international application (Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"):

Description, pages:

1-18 as originally filed

Claims, No.:

1-20 as originally filed

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

WRITTEN OPINION

International application No. PCT/IB00/00725

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been and will not be examined in respect of:

☐ the entire international application,

☒ claims Nos. 1-20,

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 1-20 are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A written opinion cannot be drawn due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

**III. NON-ESTABLISHMENT OF OPINION WITH REGARD TO NOVELTY,
INVENTIVE STEP AND INDUSTRIAL APPLICABILITY**

1. Claims 1, 7 and 10 are considered to be separate independent claims since the expression "in particular according to one of the previous claims" in the wording of claims 7 and 10 has no limiting effect on the scope of the claim, the feature following such an expression being regarded as entirely optional.

The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

Hence, claims 1, 7 and 10 do not meet the requirements of Article 6 PCT.

2. Although no statement with regard to novelty or inventive step will be done at this stage of the procedure, the attention of the applicant is drawn to document EP-A-0 768 061 (D1) which seems to disclose all the features of independent claim 1 (see for example D1, the abstract, figure 13).

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 02445PC	FOR FURTHER ACTION <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small>	
International application No. PCT/IB 00/ 00725	International filing date (day/month/year) 29/05/2000	(Earliest) Priority Date (day/month/year) 25/06/1999
Applicant DDI DIRECT DIGITAL IMAGING GMBH		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ Non of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

The abstract is modified as follows:

In order to improve an improved X-ray imaging quality an X-ray detector (14) is equipped with means (13,15) for orienting it towards an X-ray source (2) during a scan (8a,8b,27). Means (9,10,z) for reorienting a housing (10) comprising the X-ray detector (14) and a conventional cassette holder (4) and detector positioning means (9-12) cooperate to receive an X-ray beam (26a) with improved collimation quality. Thus the detection efficiency is increased, the image resolution is enhanced, and the beam exposure of patients (5) can be minimized. Embodiments relate to a linear X-ray detector (14) designed for serial readout of image pixels, a collimator (3,3a,3b) for both scanning and wide-aperture X-ray imaging, and a supporting arm (9) carrying the X-ray source (2), collimator (3) and detector arrangement (17).

PATENT COOPERATION TREATY

25. OKT. 2001						✓	N	A
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From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

E. BLUM & Co.
Vorderberg 11
8044 ZÜRICH
SUISSE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Rule 71.1)

Date of mailing
(day/month/year) 23.10.2001

Applicant's or agent's file reference
02445PC

IMPORTANT NOTIFICATION

International application No.
PCT/IB00/00725

International filing date (day/month/year)
29/05/2000

Priority date (day/month/year)
25/06/1999

Applicant
DDI DIRECT DIGITAL IMAGING GMBH et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer

Edel, M

T 1.+49 89 2399-2426



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 02445PC	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/IB00/00725	International filing date (<i>day/month/year</i>) 29/05/2000	Priority date (<i>day/month/year</i>) 25/06/1999
International Patent Classification (IPC) or national classification and IPC A61B6/00		
Applicant DDI DIRECT DIGITAL IMAGING GMBH et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 20/11/2000	Date of completion of this report 23.10.2001
Name and mailing address of the international preliminary examining authority: <div style="display: flex; align-items: center;"> <div> European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465 </div> </div>	Authorized officer Sonntag, A Telephone No. +49 89 2399 2549



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB00/00725

I. Basis of the report

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-18 as originally filed

Claims, No.:

1-5,6 (part), as originally filed
11-20

6 (part),7-10 as received on 22/09/2001 with letter of 20/09/2001

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/IB00/00725

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-20
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

- 2. Citations and explanations**
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

**V. REASONED STATEMENT WITH REGARD TO NOVELTY, INVENTIVE STEP
OR INDUSTRIAL APPLICABILITY.**

1. Reference is made to the following document:

D1: EP-A-0 768 061

2. Document D1, which is considered to represent the most relevant state of the art, discloses (see D1, the abstract, figures 6, 7, 8 and 9 page and the corresponding description) a digital X-ray scanning apparatus from which the subject-matter of claim 1 differs in particular in that:

(i) the mounting and scanning means comprise additional means for orienting the X-ray detector in at least one dimension towards the X-ray source during a digital scanning procedure

(ii) orienting movement and scanning movement are independent degrees of freedom of the X-ray detector

The subject-matter of claim 1 is therefore novel (Article 33(2) PCT).

The problem to be solved by the present invention may therefore be regarded as improving the effective receiving area of the detector.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

Neither said problem nor the solution are mentioned in the available prior art. It has to be noted that in D1 the source (44) and the detector (50) are carried on a C-arm; the tilting of the detector (50), as well as of the source (44), on figure 13 of D1 is obtained by the rotation of said C-arm about an axis (39) (see D1, figure 9). On the other hand the rotating coupling (66) (see D1, figure 7) which serves for rotating the linear detector array (50) in a plane perpendicular to the line of sight

between detector (50) and source (44) (see D1, figure 8) cannot contribute to an orienting or scanning movement of the detector (50). The rotating coupling (66) serves in fact only for reorienting the lengthy detector relative to a scanning direction between scanning procedures (see D1, page 8, lines 45-58).

3. Claims 2-20 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

VII. CERTAIN DEFECTS

1. Although claim 1 is drafted in the two-part form the feature c) of claim 1 is incorrectly placed in the characterising portion, as it is disclosed in document D1 in combination with the features placed in the preamble (Rule 6.3(b) PCT).
2. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein.
3. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

19/019323

21 531 Rec'd PCT/R 21 DEC 2001

- movement (8c) of the X-ray detector (14) and a translational or swiveling movement (27; 8a, 8d) of the X-ray source (2) or
- 5 b) several motor drive units (15) and an electrical control means (2c) for driving and synchronizing the scanning movement (8b, 27) and the orienting movement (8c) of the X-ray detector (14) and a translational or swiveling movement (27; 8a, 8d) of the X-ray source (2) are provided and
- 10 c) in particular that sliding clutches are provided between the at least one motor drive unit (15) and moving parts (2, 3, 4, 9, 10) of the X-ray apparatus (1).
- 15 7. A digital X-ray scanning apparatus (1) ~~in particular~~ according to one of the previous claims, comprising an X-ray source (2), an X-ray collimator (3), an X-ray detector (14), mounting means (9-11) for mounting the X-ray detector (14), scanning means (12, 7) for scanning (8b, 27) the X-ray detector (14) over an area
- 20 (5), means (16) for digital data acquisition from the X-ray detector (14) and a control unit (2c) for steering the X-ray apparatus (1), wherein additional photographic X-ray imaging means (2, 3, 4) comprising a cassette holder (4) for photographic films are provided, characterized in that
- 25 a) the mounting means (9-11) comprise a housing (10) that is designed for receiving the X-ray detector (14) and the cassette holder (4) in such a way that the X-ray detector (14) and the photographic film
- 30 are facing towards different side faces of the housing (10) and
- b) the mounting means (9-11) are designed for performing a reorienting movement (8z) of the housing (10) such that either the film cassette (4) or the X-ray
- 35 detector (14) is positioned for X-ray imaging.

8. The X-ray apparatus (1) according to claim 7, characterized in that
- a) the housing (10) is adapted for receiving the X-ray detector (14) on a front side (24) and the cassette holder (4) on a back side (25) and
 - b) the mounting means (9-11) has an axis (z) for rotating the front side (24) or the back side (25) of the housing (10) towards an X-ray source (2).
9. The X-ray apparatus (1) according to one of the claims 7-8, characterized in that
- a) the same X-ray source (2) is used for both digital and photographic X-ray imaging and/or
 - b) the X-ray collimator (3) is removable or a slit (3a) is openable for photographic X-ray imaging and/or
 - c) the X-ray collimator (3) or the slit (3a) is steered automatically, in particular by a sensor indicating the presence of a photographic film in the cassette holder (4) and/or by a switch in the cassette holder (4) and/or by a sensor indicating an orientation of the housing (10) for either digital or photographic X-ray imaging and/or by a manual switch and/or by means of software.
10. A digital X-ray scanning apparatus (1) ~~/in particular/~~ according to one of the previous claims, comprising an X-ray source (2), an X-ray collimator (3), an X-ray detector (14), mounting means (9-11) for mounting the X-ray detector (14), scanning means (12, 7) for scanning (8b, 27) the X-ray detector (14) over an area (5), means (16) for digital data acquisition from the X-ray detector (14) and a control unit (2c) for steering the X-ray apparatus (1), characterized in that the mounting means (9-11) are designed such that the X-ray detector (14) is held in a position shifted towards an anode side (2a) of the X-ray source (2) by an angle α , wherein $0^\circ < \alpha < \beta$ with β =anode angle.

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

From the INTERNATIONAL BUREAU

To:

E. BLUM & CO.
Vorderberg 11
CH-8400 Zürich
SUISSE

- 7. JULI 2000				V	N
LPA	NE	MS	VA	BA	F
1	2	2	2	2	2
2					

Date of mailing (day/month/year) 21 June 2000 (21.06.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 02445PC	International application No. PCT/IB00/00725

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

DDI DIRECT DIGITAL IMAGING GMBH (for all designated States except US)
TRETIKOV, Vjatcheslav et al (for US)

International filing date : 29 May 2000 (29.05.00)
Priority date(s) claimed : 25 June 1999 (25.06.99)
Date of receipt of the record copy
by the International Bureau : 31 May 2000 (31.05.00)
List of designated Offices :

AP : GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW
EA : AM, AZ, BY, KG, KZ, MD, RU, TJ, TM
EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE
OA : BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG
National : AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES,
FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ,
VN, YU, ZA, ZW

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- ☒ time limits for entry into the national phase
☐ confirmation of precautionary designations
☒ requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer:

Maria Victoria CORTIELLO

Telephone No. (41-22) 338.83.38

PARENT COOPERATION TREATY

PCT

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

From the INTERNATIONAL BUREAU

T :

E. BLUM & CO.
Vorderberg 11
CH-8400 Zürich
SUISSE

- 7. JULI 2000			
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1	1	1	1
2			

Date of mailing (day/month/year) 28 June 2000 (28.06.00)	
Applicant's or agent's file reference 02445PC	IMPORTANT NOTIFICATION
International application No. PCT/IB00/00725	International filing date (day/month/year) 29 May 2000 (29.05.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 25 June 1999 (25.06.99)
Applicant DDI DIRECT DIGITAL IMAGING GMBH et al	

- The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
- This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
- An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
- The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
25 June 1999 (25.06.99)	99112248.2	EP	06 June 2000 (06.06.00)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35	Authorized officer Zakaria EL KHODARY Telephone No. (41-22) 338.83.38
--	---

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

T :

26. JULI 2000

V N A

LPAI NF KR Vg Bh A K

E. BLUM & CO
Vorderberg 11
CH-8400 Zürich
SUISSE

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2

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Date of mailing (day/month/year) 14 July 2000 (14.07.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 02445PC	
International application No. PCT/IB00/00725	International filing date (day/month/year) 29 May 2000 (29.05.00)

1. The following indications appeared on record concerning:									
<input checked="" type="checkbox"/> the applicant	<input type="checkbox"/> the inventor <input type="checkbox"/> the agent <input type="checkbox"/> the common representative								
Name and Address DDI DIRECT DIGITAL IMAGING GMBH Neustadtstrasse 8 CH-6003 Luzern Switzerland	<table border="1"> <tr> <td>State of Nationality CH</td> <td>State of Residence CH</td> </tr> <tr> <td colspan="2">Telephone No.</td> </tr> <tr> <td colspan="2">Facsimile No.</td> </tr> <tr> <td colspan="2">Teleprinter No.</td> </tr> </table>	State of Nationality CH	State of Residence CH	Telephone No.		Facsimile No.		Teleprinter No.	
State of Nationality CH	State of Residence CH								
Telephone No.									
Facsimile No.									
Teleprinter No.									
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:									
<input type="checkbox"/> the person <input type="checkbox"/> the name <input checked="" type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence									
Name and Address DDI DIRECT DIGITAL IMAGING GMBH Seidenhofstrasse 14 CH-6003 Luzern Switzerland	<table border="1"> <tr> <td>State of Nationality CH</td> <td>State of Residence CH</td> </tr> <tr> <td colspan="2">Telephone No.</td> </tr> <tr> <td colspan="2">Facsimile No.</td> </tr> <tr> <td colspan="2">Teleprinter No.</td> </tr> </table>	State of Nationality CH	State of Residence CH	Telephone No.		Facsimile No.		Teleprinter No.	
State of Nationality CH	State of Residence CH								
Telephone No.									
Facsimile No.									
Teleprinter No.									
3. Further observations, if necessary:									
4. A copy of this notification has been sent to:									
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned								
<input checked="" type="checkbox"/> the International Searching Authority	<input type="checkbox"/> the elected Offices concerned								
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:								

The International Bureau of WIPO 34, ch min des Colombettes 1211 G neva 20, Switzerland	Authorized officer Maria Victoria CORTIELLO
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB00/00725

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-18 as originally filed

Claims, No.:

1-5,6 (part), as originally filed
11-20

6 (part),7-10 as received on 22/09/2001 with letter of 20/09/2001

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB00/00725

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-20
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

**V. REASONED STATEMENT WITH REGARD TO NOVELTY, INVENTIVE STEP
OR INDUSTRIAL APPLICABILITY.**

1. Reference is made to the following document:

D1: EP-A-0 768 061

2. Document D1, which is considered to represent the most relevant state of the art, discloses (see D1, the abstract, figures 6, 7, 8 and 9 page and the corresponding description) a digital X-ray scanning apparatus from which the subject-matter of claim 1 differs in particular in that:

(i) the mounting and scanning means comprise additional means for orienting the X-ray detector in at least one dimension towards the X-ray source during a digital scanning procedure

(ii) orienting movement and scanning movement are independent degrees of freedom of the X-ray detector

The subject-matter of claim 1 is therefore novel (Article 33(2) PCT).

The problem to be solved by the present invention may therefore be regarded as improving the effective receiving area of the detector.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

Neither said problem nor the solution are mentioned in the available prior art. It has to be noted that in D1 the source (44) and the detector (50) are carried on a C-arm; the tilting of the detector (50), as well as of the source (44), on figure 13 of D1 is obtained by the rotation of said C-arm about an axis (39) (see D1, figure 9). On the other hand the rotating coupling (66) (see D1, figure 7) which serves for rotating the linear detector array (50) in a plane perpendicular to the line of sight

between detector (50) and source (44) (see D1, figure 8) cannot contribute to an orienting or scanning movement of the detector (50). The rotating coupling (66) serves in fact only for reorienting the lengthy detector relative to a scanning direction between scanning procedures (see D1, page 8, lines 45-58).

3. Claims 2-20 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

VII. CERTAIN DEFECTS

1. Although claim 1 is drafted in the two-part form the feature c) of claim 1 is incorrectly placed in the characterising portion, as it is disclosed in document D1 in combination with the features placed in the preamble (Rule 6.3(b) PCT).
2. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein.
3. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

REPLACED BY
ART 34 AMOT

- movement (8c) of the X-ray detector (14) and a translational or swiveling movement (27; 8a, 8d) of the X-ray source (2) or
- 5 b) several motor drive units (15) and an electrical control means (2c) for driving and synchronizing the scanning movement (8b, 27) and the orienting movement (8c) of the X-ray detector (14) and a translational or swiveling movement (27; 8a, 8d) of the X-ray source (2) are provided and
- 10 c) in particular that sliding clutches are provided between the at least one motor drive unit (15) and moving parts (2, 3, 4, 9, 10) of the X-ray apparatus (1).
7. A digital X-ray scanning apparatus (1), in particular
- 15 according to one of the previous claims, comprising an X-ray source (2), an X-ray collimator (3), an X-ray detector (14), mounting means (9-11) for mounting the X-ray detector (14), scanning means (12, 7) for scanning (8b, 27) the X-ray detector (14) over an area
- 20 (5), means (16) for digital data acquisition from the X-ray detector (14) and a control unit (2c) for steering the X-ray apparatus (1), wherein additional photographic X-ray imaging means (2, 3, 4) comprising a cassette holder (4) for photographic films are provided, characterized in that
- 25 a) the mounting means (9-11) comprise a housing (10) that is designed for receiving the X-ray detector (14) and the cassette holder (4) in such a way that the X-ray detector (14) and the photographic film
- 30 are facing towards different side faces of the housing (10) and
- b) the mounting means (9-11) are designed for performing a reorienting movement (8z) of the housing (10) such that either the film cassette (4) or the X-ray
- 35 detector (14) is positioned for X-ray imaging.

8. The X-ray apparatus (1) according to claim 7, characterized in that
- a) the housing (10) is adapted for receiving the X-ray detector (14) on a front side (24) and the cassette holder (4) on a back side (25) and
 - b) the mounting means (9-11) has an axis (z) for rotating the front side (24) or the back side (25) of the housing (10) towards an X-ray source (2).
9. The X-ray apparatus (1) according to one of the claims 7-8, characterized in that
- a) the same X-ray source (2) is used for both digital and photographic X-ray imaging and/or
 - b) the X-ray collimator (3) is removable or a slit (3a) is openable for photographic X-ray imaging and/or
 - c) the X-ray collimator (3) or the slit (3a) is steered automatically, in particular by a sensor indicating the presence of a photographic film in the cassette holder (4) and/or by a switch in the cassette holder (4) and/or by a sensor indicating an orientation of the housing (10) for either digital or photographic X-ray imaging and/or by a manual switch and/or by means of software.
10. A digital X-ray scanning apparatus (1), in particular according to one of the previous claims, comprising an X-ray source (2), an X-ray collimator (3), an X-ray detector (14), mounting means (9-11) for mounting the X-ray detector (14), scanning means (12, 7) for scanning (8b, 27) the X-ray detector (14) over an area (5), means (16) for digital data acquisition from the X-ray detector (14) and a control unit (2c) for steering the X-ray apparatus (1), characterized in that the mounting means (9-11) are designed such that the X-ray detector (14) is held in a position shifted towards an anode side (2a) of the X-ray source (2) by an angle α , wherein $0^\circ < \alpha < \beta$ with β =anode angle.

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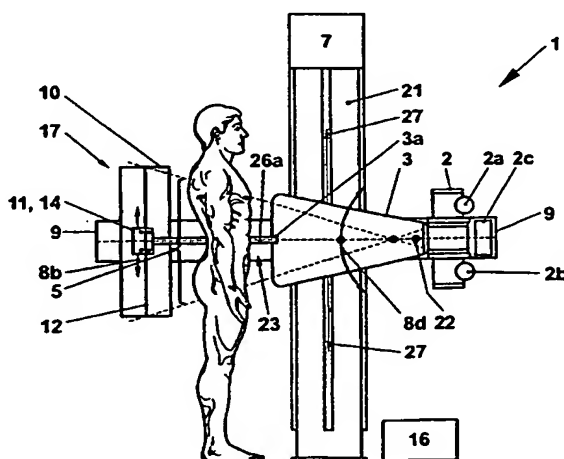
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(54) Title: **DIGITAL X-RAY SCANNING APPARATUS**



(57) Abstract: In order to improve an improved X-ray imaging quality an X-ray detector (14) is equipped with means (13, 15) for orienting it towards an X-ray source (2) during a scan (8a, 8b, 27). Means (9, 10, 12) for reorienting a housing (10) comprising the X-ray detector (14) and a conventional cassette holder (4) and detector positioning means (9-12) cooperate to receive an X-ray beam (26a) with improved collimation quality. Thus the detection efficiency is increased, the image resolution is enhanced, and the beam exposure of patients (5) can be minimized. Embodiments relate to a linear X-ray detector (14) designed for serial readout of image pixels, a collimator (3, 3a, 3b) for both scanning and wide-aperture X-ray imaging, and a supporting arm (9) carrying the X-ray source (2), collimator (3) and detector arrangement (17).

Digital X-Ray Scanning Apparatus

Cross Reference to Related Application

This application claims the priority of the European patent application No. 99112248.2, filed on June 25, 1999, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The invention refers to the field of X-ray imaging for medical and other purposes. It is based on the subject-matter as set forth in the preamble of the independent claims.

BACKGROUND ART

The invention refers to a state of the art as known from the U. S. Pat. No. 4,773,087, in which a conventional photographic X-ray imaging system for full body or partial body imaging is disclosed. The system is equipped with a scanning digital detector for monitoring primary and scattered X-ray radiation. The laterally extended detector is positioned behind a film cassette and is addressed linewise and linearly shifted up and down for providing a two-dimensional scan of the film cassette area. The digital detector signal is used as a feedback signal for controlling the X-ray source in order to improve the photographic image quality.

However, the digital sensor by its own cannot deliver a useful X-ray image of the patient's body. The digital image quality, in particular the spatial resolution, scattering, dynamic range and sensitivity, is inappropriate for medical X-ray imaging. The disclosed digital scanning system shows insufficient performance in several re-

spects: the detector is positioned in a rather large distance from the patient's body and behind the loaded film cassette, thereby enhancing X-ray scattering; the vertical scanning range of the detector is limited by a decrease of the effective aspect ratio and hence sensitivity when the detector is moved out of a position facing the X-ray source; as detector an image intensifier plate is proposed that suffers from low X-ray sensitivity and large optical scattering; furthermore the optical readout of the image intensifier plate is accomplished by a plurality of moving parts that add considerable mechanical complexity to the digital detector.

In the EP 0 291 299 a digital X-ray scanning system for partial or full body imaging is shown. A bar-shaped movable scintillator body and a multi-line photodetector are scanned synchronously with a moving X-ray beam across the stationary patient. The scan is performed by a linear translation of the detector arrangement and the collimator, which selects radiation from a wide-aperture X-ray source. A major problem is the fact that the patient cannot lean still at the X-ray apparatus, because the collimator in the front and the detector in the back of the patient are vertically moving. It is therefore difficult or impossible to maintain constant and reproducible distances collimator-patient and/or patient-detector during the scan. Furthermore, the patient must keep a certain (too large) minimal distance to the detector. Another problem is the loss of X-ray energy and the varying X-ray beam density or focus quality, that arise from using the wide-angle source and moving collimator. Consequently the overall image quality and in particular the spatial resolution are limited and are still considerably lower than in conventional photographic X-raying systems.

In the EP 0 904 734 a combined digital X-ray scanning and photographic system for panoramic dental X-ray imaging is disclosed. The X-ray source and the digital sensor

cassette or film cassette are mounted on a rotary arm in fixed positions thereby facing each other. A panoramic X-ray image of teeth is generated by rotating the arm about a vertical axis centered at the patient's head and by sequentially reading out a vertical linear sensing array or by horizontally shifting a film cassette along a vertical collimator slit. Obviously X-ray imaging with a rotary movement is only feasible when scanning a head or other round body parts and preferentially small areas. The rotary movement is inadequate to scan longitudinally extended body parts, because the variations in imaging distance would by far exceed the depth of focus and blur the image. Therefore the system is incapable of producing full body images. Other disadvantages are, that the patient may not secure his head position by leaning to the rotary arm during a scan, and that the digital sensor cassette must be removed when a film cassette is mounted.

BRIEF SUMMARY OF THE INVENTION

It is the object of the invention to provide an improved digital X-ray system suitable for fast, large-area as well as high resolution X-ray imaging. This object is achieved according to the invention by the subject-matter as set forth in the independent claims.

The invention discloses novel means for orienting or positioning X-ray imaging means with respect to an X-ray source in order to achieve an improved X-ray imaging quality. More specifically, the invention resides in a special detector arrangement comprising a scanning X-ray detector, wherein an additional degree of freedom for reorienting the detector towards an X-ray source is provided, or wherein the detector housing further comprises a photographic plate and is reorientable for switching between digital scanning and high resolution photographic X-ray imaging, or wherein the digital scanning detector is positioned under an angle shifted towards an anode

side of the X-ray tube in order to exploit an improved collimation quality of the X-ray beam. Thus, in the first aspect, the effective receiving area of the digital detector is increased, in the second aspect, the digital scanning is complemented by conventional high resolution imaging by providing mounting means for orienting either the digital detector or the photographic plate relative to the X-ray beam, and, in the third aspect, mounting means for orienting the digital detector are provided such that an X-ray beam can be received with minimum beam divergence. By these measures the detection efficiency is increased, the image resolution is enhanced and the beam exposure of patients can be minimized.

In the first aspect of the invention a digital X-ray scanning apparatus comprises an X-ray source, collimator, mounting and scanning means for a detector, digital data acquisition means and a control unit for steering the X-ray apparatus, wherein additional mounting and scanning means are provided for orienting the X-ray detector in at least one dimension towards the X-ray source independent from and in coordination with a digital scanning movement. Thus the detector efficiency is clearly improved. In particular the effective receiving area of the detector can be kept constant in at least one dimension even in extreme detector positions during the scan. By providing at least two separate degrees of freedom for the X-ray detector the scanning and orienting movements of the X-ray detector can be controlled and optimized independently from each other.

Embodiments refer to translational means for moving the X-ray detector on a linear path. By choosing a linear scanning movement along the patient's body the distance patient-detector can be kept constant which leads to a uniform and high image quality throughout the X-ray scan. Alternatively the X-ray detector can be moved along a curved or circular path about the X-ray source such that the distance source-detector is kept constant. Rotational means for orienting the X-ray detector can be implemented such that an aspect ratio of the X-ray detector as viewed

from the X-ray source is maintained throughout a scan. A single-line or few- or multi-line digital detector is well suited geometrically for linewise scanning an extended object such as a patient's body and serially reading out the detector in order to generate a two-dimensional image. As well, a single- or multi-line digital X-ray detector is advantageous over a large two-dimensional detector array since massive parallel data processing is avoided and only rather modest computing power is required.

In specific embodiments a carriage having a rotatable plate for receiving an elongated single- or multi-line X-ray detector is provided, wherein the carriage is movable in a direction essentially perpendicular to its lateral extension. In this set-up large area scans, as required for digital partial or full body X-ray imaging, can be realized with unprecedented image quality and little computing power. The means for scanning and orienting the X-ray detector can be mounted inside a housing that remains stationary during a scan. The patient can then lean to the housing in order to maintain a constant distance to the detector. Thereby the quality and repeatability of digital X-ray imaging is further improved. Moreover, a swiveling mounting of the X-ray source, a mechanical or electrical coupling between the scanning and orienting movement of the X-ray detector and the swiveling or translational movement of the X-ray source, and sliding clutches for a safe operation of the apparatus may be provided.

In the second aspect of the invention a digital X-ray scanning apparatus comprises an X-ray source, collimator, mounting and scanning means for a detector, digital data acquisition means, a control unit for steering the X-ray apparatus and additional photographic X-ray imaging means including a cassette holder for photographic films, wherein a common housing is provided for receiving the X-ray detector and the cassette holder in such a way that they are facing towards different side faces of the housing, and the housing is reorientable such that either the

film cassette or the X-ray detector is positioned for X-ray imaging. As a consequence, the X-ray detector and the cassette holder for photographic films are permanently installable in the X-ray apparatus. It is sufficient to
5 reorient the common detector/cassette holder housing and to adapt the X-ray collimator in order to switch between digital and conventional X-ray imaging. There is no need to store either the detector or the film cassette in a separate place. Thus switching between digital and con-
10 ventional X-ray imaging is strongly facilitated.

Moreover, the range of application of the digital X-ray scanning apparatus is favourably enlarged by integrating photographic X-ray imaging means in such a way. The digital subsystem serves for fast X-raying parts or the to-
15 tality of a human or animal body or other extended object. Such X-ray scans may be monitored on a TV screen and/or may be image processed, stored, archived and retrieved electronically. By switching to the photographic subsystem specific body parts or object details can be
20 investigated in greater detail and with higher resolution. The photographic subsystem is particularly useful for imaging bone structures and performing special examinations, such as mammography. The easy handling of both subsystems according to invention is of great advantage
25 for medical personnel.

Embodiments refer to a housing which has the X-ray detector mounted on a front side and the cassette holder on a back side and which is rotatable such that either the front or back side is facing towards an X-ray source.
30 Preferable implementations have any of the following features: the same X-ray source is utilized for digital and conventional X-ray imaging; the X-ray collimator is removable or openable for photographic X-ray imaging; and the removal or opening is steered automatically, e. g. by
35 a sensor indicating the presence of a photographic film in the cassette holder, by a switch in the cassette holder, by a sensor indicating an orientation of the housing for either digital or photographic X-ray imaging, by means of software and/or by a manual switch.

In the third aspect of the invention a digital X-ray scanning apparatus comprises an X-ray source, collimator, mounting and scanning means for a detector, digital data acquisition means and a control unit for steering the X-ray apparatus, wherein mounting means for holding the X-ray detector in a position shifted towards an anode side of the X-ray source by an angle α are provided, wherein $0^\circ < \alpha < \beta$ with β =anode angle. This detector orientation is specifically chosen to benefit from an improved X-ray beam quality and it allows to minimize the X-ray exposure of patients during digital X-ray scans.

In a preferred embodiment the positioning angle α is selected around $\beta/2$ and, in particular $4^\circ < \alpha < 12^\circ$, preferably $\alpha = 6^\circ$ with $\beta = 12^\circ$.

Other embodiments relate to an integrated collimator design wherein the collimator is easily switchable between a collimated X-ray beam for digital X-ray scanning and a broad or wide-angle beam for conventional photographic X-ray imaging.

Further embodiments refer to the X-ray detector comprising a single- or multi-line array of scintillator crystals that are coupled to optical detectors, to an A/D converter and to a personal computer for serial readout.

A yet other embodiment addresses the dimensioning of the X-ray apparatus, in particular for fast digital full body imaging with improved image quality, by choosing appropriate distances source-detector, collimator-detector and patient-detector for adapting the beam shape to the digital detector dimensions and for minimizing X-ray scattering. Thereby digital imaging with image resolution better than 2 linepairs per mm is achievable with very low X-ray doses.

Final embodiments describe the design of a rotatable supporting arm for mounting an X-ray source with collimator and an X-ray detector, wherein the source plus collimator

and the detector are individually tiltable and optionally the source-detector distance is variable.

Other objects, features and advantages of the present invention will become apparent from the dependent claims
5 and the description in connection with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The description is related to the accompanying drawings, in which

10 Fig. 1 shows a general schematic of a digital scanning X-ray apparatus comprising a detector arrangement according to invention;

Fig. 2 shows a first detector arrangement with a scanning and orienting mechanism suitable for large area digital X-ray imaging;

15 Fig. 3 shows a second detector arrangement that comprises a photographic plate and is reorientable for either digital or conventional X-ray imaging;

20 Fig. 4 shows an embodiment with an X-ray collimator that is switchable between a narrow and a wide aperture for digital and conventional X-ray imaging;

Fig. 5 shows a third detector arrangement wherein the position of a digital scanning detector is shifted by an angle towards an anode side of the X-ray tube;

25 Fig. 6 shows an embodiment of the x-ray apparatus wherein an X-ray beam is aligned or scanned by swiveling a supporting arm; and

30 Fig. 7 shows an embodiment of the x-ray apparatus wherein an X-ray beam is aligned or scanned by translating a supporting arm.

In the drawings identical parts are designated by identical reference numerals.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention refers to an X-ray apparatus 1 as exemplified in Fig. 1. The apparatus 1 comprises an X-ray source 2 with an anode 2a and a cathode 2b (indicated schematically), a collimator 3 with a collimator slit 3a and an X-ray detector arrangement 17, a supporting arm 9 for holding the X-ray source 2 and the detector arrangement 17 and a structure or mount 21 for suspending the supporting arm 9. The detector arrangement 17 includes mounting and scanning means 10-12 for an X-ray detector 14. These means 10-12 comprise a detector housing 10 and a carriage 11 that is movable along guiding rails 12. The scanning means further comprise at least one motor 7. Means 16 for digital data acquisition from the X-ray detector 14 and a control unit 2c for steering the X-ray apparatus 1 are provided. A digital image of a patient's body is generated by scanning a collimated X-ray beam 26a over an area 5 and coordinately moving the carriage 11 with the detector 14 along a path 8b and/or 27. For this purpose the X-ray source 2 is swiveled, as indicated by arrows 8d, about a suspension point 22; alternatively it can be linearly translated (Fig. 7). The lateral extensions of the collimator slit 3a and of the detector 14 determine the width of the image to be scanned. However, it is also possible to perform a scanning movement of the X-ray source 2 and/or collimator slit 3a and the detector 14 in two dimensions. The supporting arm 9 may contain means 23 for driving moving parts 10, 11, 2, 3, 3a mounted to it. The supporting arm 9 itself can be shiftable, as indicated by arrows 27, along the structure 21. The orientation of the structure 21 and of the supporting arm 9 is adapted to the patient's position. Typically the structure 21 is vertical, when the patient is standing (as shown) or sitting, and it is horizontal, when the patient is lying. The supporting arm 9 can be oriented perpendicularly or otherwise tilted with respect to the structure 21.

Fig. 2 shows, in a first general aspect of the invention, additional mounting and scanning means 13, 15 for performing in at least one dimension an orienting movement 8c of the X-ray detector 14 towards the X-ray source 2 during a digital scanning procedure, wherein the orienting movement 8c and the scanning movements 8b and/or 27 are independent degrees of freedom of the X-ray detector 14, and the X-ray apparatus 1 is designed for steering the orienting movement 8c of the X-ray detector 14 in coordination with the scanning movement 8b and/or 27 of the X-ray detector 14.

The mounting and scanning means 9-12, 7 shall comprise translational means 11, 12 for moving the X-ray detector 14 along a straight line segment 8b, 27 or along a curved or circular line segment inside the housing 10 or possibly together with the housing 10 (Fig. 6, arrows 8a); and/or the additional means 13, 15 comprise rotational means 13, 15 for tilting the X-ray detector 14 in order to maintain a constant aspect ratio of the X-ray detector 14 as viewed from the X-ray source 2; and/or the X-ray detector 14 is a single- or multi-line digital X-ray detector 14 useful for linewise scanning large areas 5.

The translational means 11 shown in Fig. 2 is a carriage 11 that is movable in a direction perpendicular to its lateral extension, the rotational means 13 is a rotatable plate 13 that is mounted on the carriage 11 and is designed for receiving the X-ray detector 14, and, in particular, the rotatable plate 13 is laterally extended for receiving an elongated single-line digital X-ray detector 14 suitable for partial or full body X-ray scanning 8a, 8b, 8d, 27. The plate 13 can be rotated by a motor drive unit 15 such that the X-ray detector 14 is oriented in one dimension towards the X-ray source 2 during a digital scanning movement 8b, 27.

In a preferred embodiment a housing 10 for receiving the translational and rotational means 11, 12, 13 is provided, which housing 10 can be kept motionless or stationary during the scanning procedure. In particular the

mounting and scanning means 9-12, 7 comprise means 9, 7, such as the supporting arm 9 and the motor 7, for repositioning the housing 10 for different scanning procedures. Alternatively, the housing 10 can be moved itself during
5 a scan. Thereby a combined scanning movement 8b, 27 in coordination with an orienting movement 8c of the detector 14 is implemented.

Fig. 3 shows, in a second general aspect of the invention, a detector arrangement 17 with combined digital/
10 photographic detection means 4, 14 for an X-ray apparatus according to Fig. 1. In this configuration additional photographic X-ray imaging means 2, 3, 4 comprising a cassette holder 4 for photographic films are provided. According to invention the mounting means 9-11 comprise a
15 housing 10 that is designed for receiving the X-ray detector 14 and the cassette holder 4 in such a way that the X-ray detector 14 and the photographic film are facing towards different side faces of the housing 10 and the mounting means 9-11 are designed for performing a re-
20 orienting movement 8z of the housing 10 such that either the film cassette 4 or the X-ray detector 14 is positioned for X-ray imaging. The housing 10 of the integrated photographic/digital detector 17 may be closed or may have open faces. This detector arrangement is very
25 advantageous because the digital detector 14 and the cassette holder 4 are always at hand. Switching between the digital and conventional X-ray imaging mode is simplified a lot compared to state of the art devices. Besides that, the rotational switching between both detection means 14,
30 4 allows to return precisely to a previous position of the digital scanning detector 14 after photographic imaging.

In detail Fig. 3 shows a housing 10 that is adapted for receiving the X-ray detector 14 on a front side 24 and
35 the cassette holder 4 on a back side 25, and the mounting means 9-11 have an axis z for rotating the front side 24 or the back side 25 of the housing 10 towards an X-ray source 2. Preferably the axis z is oriented horizontally or vertically, corresponding to whether Fig. 3 presents a

top view or side view. A torque-free suspension of the housing 10 is possible by positioning the rotational axis z at the center of gravity of the combined detector housing 10. As shown in Fig. 3a the X-ray beam is collimated 26a when the detector 14 is oriented towards the X-ray source 2. The detector 14 can, but need not be equipped with the previously described means 9-12, 7, 13, 15 for a linear scanning movement 8b, 27 and a rotational orienting movement 8c. According to Fig. 3b a broad X-ray beam 26b is used when a photographic film in a conventional cassette holder 4 shall be exposed. Note that the film and cassette holder 4 are shown only schematically.

Preferred embodiments are related to any of the following features: a use of the same X-ray source 2 for both digital and photographic X-ray imaging; an X-ray collimator 3 that is removable or a slit 3a that is openable for photographic X-ray imaging; an X-ray collimator 3 or a slit 3a that is steered automatically, in particular by a sensor indicating the presence of a photographic film in the cassette holder 4, by a switch in the cassette holder 4, by a sensor indicating an orientation of the housing 10 for digital or photographic X-ray imaging, by a manual switch, and/or by means of software.

Fig. 4 shows a collimator 3 according to invention that is useful for both digital and photographic imaging. The essentially cone-shaped collimator 3 is rigidly attached to the X-ray source 2. The X-ray collimator 3 has an opening 3b for photographic imaging and comprises at least one movable shutter 19a with a built-in collimator slit 3a to provide a precisely collimated beam 26a for digital X-ray scanning. By this design a rectangular beam profile is provided that can easily and efficiently be widened or narrowed for photographic or digital imaging. Desirable features are: an X-ray collimator 3 comprising one or two pivoted shutters 19a, 19b; an X-ray collimator 3 comprising a turning knob 18 to open or close the at least one shutter 19a, 19b; a shutter 19a having means 20 for adjusting a position of the slit 3a and/or a width y of the slit 3a in a range $0.2 \text{ mm} < y < 5 \text{ mm}$; and/or an

X-ray collimator slit 3a that is positioned in a fixed distance from the X-ray source 2.

Preferably means for swiveling 8d the X-ray source 2 and the collimator 3, 3a in coordination with the scanning
5 movement 8b, 27 and orienting movement 8c of the X-ray detector 14 are provided. In particular a balanced suspension about an axis 22 extending through the center of gravity of the X-ray source 2 and the collimator 3, 3a is provided for a torque-free swiveling movement 8d. As
10 well, means for a rotational movement 8a (Fig. 6) or a linear movement 27 (Fig. 7) of the source 2 and collimator 3 in coordination with the movement 8b, 27, 8c of the detector 14 may be implemented. A counterweight for a force-free linear movement 8a would then be desirable. A
15 hand grip 6 for swiveling and/or linearly shifting the source 2 and collimator 3 is shown as well.

A motor drive unit 15 and mechanical coupling means 23 are provided for synchronously driving the scanning movement 8b, 27 and the orienting movement 8c of the X-ray
20 detector 14 and a translational or swiveling movement 27; 8a, 8d of the X-ray source 2 (Fig. 1, 4, 6 and 7). The mechanical coupling means 23 can be e. g. a chain drive or a synchronous belt drive. These rather simple means allow for a high precision of synchronization between the
25 at least two degrees of freedom 8b, 27; 8c of the detector 14 and the movement 27; 8a, 8d of the source 2 plus collimator 3, 3a. Alternatively several motor drive units 15 and an electrical control means 2c for driving and synchronizing the scanning movement 8b, 27 and the ori-
30 enting movement 8c of the X-ray detector 14 and a translational or swiveling movement 27; 8a, 8d of the X-ray source 2 are provided. With such an electrical synchronization it is most simple to provide for a variable collimator-detector distance. For safety reasons sliding
35 clutches can be built in between the at least one motor drive unit 15 and moving parts 2, 3, 4, 9, 10 of the X-ray apparatus 1.

Fig. 5 shows, in a general third aspect of the invention, a digital X-ray scanning apparatus 1, as known from Fig. 1, wherein the mounting means 9-11 are designed such that the X-ray detector 14 is held in a position shifted
5 towards an anode side 2a of the X-ray source 2 by an angle α , where $0^\circ < \alpha < \beta$ with β =anode angle. Note that the anode 2a is shown in actual shape and orientation, but not to scale, whereas the cathode 2b is only indicated schematically. This detector orientation is chosen for
10 receiving an X-ray beam with high collimation quality such that the X-ray dosage during the digital X-ray scan can be minimized.

The optimal choice of positioning angle α results, according to invention, from a trade off between emitted
15 intensity and apparent focal spot size F' . The intensity emitted under anode angle β , i. e. tangentially to the anode surface, is considerably filtered and decreased, mainly owing to the surface roughness of the anode material. The intensity strongly increases for decreasing po-
20 sitioning angles $\alpha < \beta$ and typically reaches 90% of its maximal value at α approximately equal to $\beta/2$. On the other hand the apparent focal size equals $F' = F \cdot \sin(\beta - \alpha) / \sin(\beta)$ with F =actual focal spot size. F' is minimal, or ideally zero, for $\alpha = \beta$ and increases with de-
25 creasing positioning angles $\alpha < \beta$. Preferably the position- ing angle shall be chosen around $\alpha = \beta/2$ for receiving a high-intensity X-ray beam with focal spot size reduced by a factor 2. Conventional X-ray tubes 2 have anode target angles β between 12° and 16° . Consequently a useful range
30 of positioning angles is $4^\circ < \alpha < 12^\circ$, preferred $6^\circ < \alpha < 8^\circ$, and most preferably $\alpha = 6^\circ$ when $\beta = 12^\circ$ is assumed.

For the X-ray detector 14 a single- or multi-line X-ray detector 14 with X-ray sensitive elements (not shown) may be chosen. In particular the X-ray sensitive elements or
35 pixels comprise scintillator crystals and optical detectors, that are connected to at least one A/D converter and to a microcomputer 16 for serial readout. By a care-

ful choice of scintillators and detectors a high sensitivity can be achieved. A single- or multi-linear array is clearly superior to full image detectors that require enormous parallel computing power for readout. In contrast the invention takes advantage of a fast serial pixel readout that can be accomplished with commercially available personal computers. The serial readout is repeated linewise during the scanning process.

In further embodiments the single- or multi-line X-ray detector 14 has means for timing control of the single- or multi-line X-ray detector 14. The single- or multi-line X-ray detector 14 has means for gain and/or offset correction of analog signals from each pixel and/or from the whole single- or multi-line X-ray detector 14. With advantage the single- or multi-line X-ray detector 14 has a digital signal processor for detector control and data acquisition and/or it has a digital memory for data acquisition and data storage.

According to another embodiment the X-ray dosage and scattering radiation during digital X-ray scanning can be further reduced by an adequate choice of the geometrical beam parameters, such as apparent focal spot size F' of the X-ray source 2, collimator slit width y and distances d_1 between the X-ray source 2 (in particular its apparent focus) and the X-ray detector 14, d_2 between the X-ray collimator slit 3a and the X-ray detector 14 and d_3 between the patient 5 and the X-ray detector 14 (Fig. 5). The goals of an optimal parameter choice are: (i) fan beam width at detector site $<$ pixel width (given by the width of the effective receiving area of the scintillator crystal); (ii) reduce half-shadow zones to diminish radiation passing by the detector 14; thereby the patient's X-ray exposure is further minimized; (iii) provide sufficient absolute intensity; and (iv) small patient-detector distance d_3 to reduce scattering from the X-rayed object. Therefore a slit width y of the order of or smaller than

the width of the receiving area of the scintillator crystal shall be chosen. The half-shadow zones result from the finite apparent focal spot size F' geometrically imaged through the collimator slit 3a. The intensity side lobes extending laterally over more than one pixel size are kept low by decreasing F' , y and the image distance d_2 . For providing enough absolute intensity the slit width y must be large enough. Finally the patient-detector distance d_3 shall be short.

Advantageously the X-ray apparatus 1 is dimensioned for full or partial body digital X-ray imaging. For this purpose and for a given pixel size (in particular width of effective receiving area of scintillator crystal) of 0.4 mm preferred parameter ranges are: slit width 0.2 mm < y < 1.5 mm; overall distance 900 mm < d_1 < 1450 mm; image distance 500 mm < d_2 < 700 mm; and patient-detector distance 10 mm < d_3 < 200 mm.

Fig. 1, 6 and 7 show the mechanical design and modes of movability of the X-ray apparatus 1 as a whole. The supporting arm 9 is adapted for carrying the X-ray source 2, the X-ray collimator 3 and the detector arrangement 17, according to invention, with the housing 10 comprising the X-ray detector 14. The supporting arm 9 itself shall be suspended in a rotatable fashion 8a. The X-ray source 2 together with the X-ray collimator 3 and the detector housing 10 are tiltable with respect to the supporting arm 9 in order to position the X-ray source 2, the X-ray collimator 3 and the detector 14 for X-raying a standing, sitting or lying patient 5.

Preferably the X-ray source 2 and/or the housing 10 for the X-ray detector 14 are movable along the supporting arm 9 for selecting a distance d_1 between the X-ray source 2 and the X-ray detector 14 or, in particular, a photographic film in a cassette holder 4 mounted in the housing 10.

Fig. 6 shows an example wherein the rotational or swiveling movement 8a of the supporting arm 9 is used to position and/or to scan the X-ray source 2 plus collimator 3 and the detector arrangement 17 with respect to the patient's body. The axis of rotation 8a may be located at the X-ray source 2, as shown, or may be shifted e.g. towards the patient 5. The transverse bar 9 in the middle position (A) (straight lines) is oriented horizontally or vertically depending on whether the patient 5 is standing/sitting or lying. The bar 9 may also be oriented under arbitrary angles relative to the patient 5. The dashed lines indicate the extreme positions (B), (C) of the swiveling movement 8a. Owing to the bar 9 the detector arrangement 17 containing the detector 14 (with or without cassette holder 4) and the X-ray collimator 3 travel coordinately on a circle segment. This motion might also be achieved using separate mountings for the detector arrangement 17 and collimator 3. Alternatively the detector arrangement 17 may be suspended independently and be movable along a straight line segment 27 and in coordination with the swiveling movement of the X-ray collimator 3 and X-ray source 2 or possibly the scanning movement 8b, 27 of the carriage 11. The movements 8a, 8b and 27 shall again be driven by at least one motor 7.

Fig. 7 shows an example wherein the supporting arm 9 has a suspension that is movable horizontally 27 for X-raying a lying patient 5. The detector arrangement 17 is movable 27 underneath the patient's body 5. In comparison, Fig. 1 shows a supporting arm 9 having a suspension that is movable vertically 27 for X-raying a standing or sitting patient 5. With advantage the supporting arm 9 is rotatable by at least 90° in order to switch between X-raying a standing or sitting and a lying patient 5.

The versatile movability of the supporting arm 9 is helpful for a fast alignment of the X-ray apparatus 1 with respect to the patient 5. Furthermore, a rotation 8a of the supporting arm 9 can be used to support or perform a

swiveling movement 8d of the X-ray source 2 and/or of the detector arrangement 17. As well, a translation 27 of the supporting arm 9 can be used to support or perform a linear movement 27 of the X-ray source 2 and/or a scanning movement 8b of the detector 14.

In conclusion the invention discloses novel means 9-12, 7, 13, 15 for orienting or positioning X-ray imaging means 14, 4 with respect to an X-ray source 2 in order to achieve an improved X-ray imaging quality. According to invention a reorientable X-ray scanning detector 14, a reorientable combined scanning and photographic X-ray imaging means 14, 4 and means 9-12 for an improved detector positioning are provided. Thus the detection efficiency and image resolution are substantially increased. The new detector arrangement 17 is particularly useful for quick and efficient X-ray imaging of large areas 5 using digital or complementary conventional detection means 14, 4.

PATENT CLAIMS

1. A digital X-ray scanning apparatus (1) comprising an X-ray source (2), an X-ray collimator (3), an X-ray detector (14), mounting means (9-11) for mounting the
5 X-ray detector (14), scanning means (12, 7) for scanning (8b, 27) the X-ray detector (14) over an area (5), means (16) for digital data acquisition from the X-ray detector (14) and a control unit (2c) for steering the X-ray apparatus (1), characterized in that
 - 10 a) the mounting and scanning means (9-12, 7) comprise additional means (13, 15) for orienting (8c) the X-ray detector (14) in at least one dimension towards the X-ray source (2) during a digital scanning procedure,
 - 15 b) wherein an orienting movement (8c) and a scanning movement (8b, 27) are independent degrees of freedom of the X-ray detector (14) and
 - c) the X-ray apparatus (1) is designed for steering the orienting movement (8c) of the X-ray detector
20 (14) in coordination with the scanning movement (8b, 27) of the X-ray detector (14).
2. The X-ray apparatus (1) according to claim 1, characterized in that
 - 25 a) the mounting and scanning means (9-12, 7) comprise translational means (11, 12) for moving the X-ray detector (14) along a straight line segment (8b, 27) or along a curved or circular line segment and/or
 - b) the additional means (13, 15) comprise rotational
30 means (13, 15) for tilting (8c) the X-ray detector (14) in order to maintain a constant aspect ratio of the X-ray detector (14) as viewed from the X-ray source (2) and/or
 - c) the X-ray detector (14) is a single- or multi-line
35 digital X-ray detector (14).

3. The X-ray apparatus (1) according to claim 2, characterized in that
- a) the translational means (11) is a carriage (11) that is movable in a direction perpendicular to its lateral extension,
 - b) the rotational means (13) is a rotatable plate (13) that is mounted on the carriage (11) and is designed for receiving the X-ray detector (14), and
 - c) in particular that the rotatable plate (13) is laterally extended for receiving an elongated single-line digital X-ray detector (14) suitable for partial or full body X-ray scanning (8a, 8b, 27).
4. The X-ray apparatus (1) according to one of the claims 2-3, characterized in that
- a) a housing (10) for receiving the translational and rotational means (11, 13) is provided, which housing (10) can be kept stationary during the scanning movement (8b, 27) and
 - b) in particular that the mounting and scanning means (9-12, 7) comprise means (9, 7) for repositioning the housing (10) for different scanning procedures.
5. The X-ray apparatus (1) according to one of the previous claims, characterized in that
- a) means for swiveling (8d) the X-ray source (2) and the collimator (3, 3a) in coordination with the scanning movement (8b, 27) and orienting movement (8c) of the X-ray detector (14) are provided and
 - b) in particular that a balanced suspension of the X-ray source (2) and the collimator (3, 3a) for a torque-free swiveling movement (8d) is provided.
6. The X-ray apparatus (1) according to one of the previous claims, characterized in that
- a) a motor drive unit (15) and mechanical coupling means (23) are provided for synchronously driving the scanning movement (8b, 27) and the orienting

movement (8c) of the X-ray detector (14) and a translational or swiveling movement (27; 8a, 8d) of the X-ray source (2) or

5 b) several motor drive units (15) and an electrical control means (2c) for driving and synchronizing the scanning movement (8b, 27) and the orienting movement (8c) of the X-ray detector (14) and a translational or swiveling movement (27; 8a, 8d) of the X-ray source (2) are provided and

10 c) in particular that sliding clutches are provided between the at least one motor drive unit (15) and moving parts (2, 3, 4, 9, 10) of the X-ray apparatus (1).

7. A digital X-ray scanning apparatus (1), in particular
15 according to one of the previous claims, comprising an X-ray source (2), an X-ray collimator (3), an X-ray detector (14), mounting means (9-11) for mounting the X-ray detector (14), scanning means (12, 7) for scanning (8b, 27) the X-ray detector (14) over an area
20 (5), means (16) for digital data acquisition from the X-ray detector (14) and a control unit (2c) for steering the X-ray apparatus (1), wherein additional photographic X-ray imaging means (2, 3, 4) comprising a cassette holder (4) for photographic films are provided, characterized in that
25

a) the mounting means (9-11) comprise a housing (10) that is designed for receiving the X-ray detector (14) and the cassette holder (4) in such a way that the X-ray detector (14) and the photographic film
30 are facing towards different side faces of the housing (10) and

b) the mounting means (9-11) are designed for performing a reorienting movement (8z) of the housing (10) such that either the film cassette (4) or the X-ray
35 detector (14) is positioned for X-ray imaging.

8. The X-ray apparatus (1) according to claim 7, characterized in that
- a) the housing (10) is adapted for receiving the X-ray detector (14) on a front side (24) and the cassette holder (4) on a back side (25) and
 - b) the mounting means (9-11) has an axis (z) for rotating the front side (24) or the back side (25) of the housing (10) towards an X-ray source (2).
9. The X-ray apparatus (1) according to one of the claims 7-8, characterized in that
- a) the same X-ray source (2) is used for both digital and photographic X-ray imaging and/or
 - b) the X-ray collimator (3) is removable or a slit (3a) is openable for photographic X-ray imaging and/or
 - c) the X-ray collimator (3) or the slit (3a) is steered automatically, in particular by a sensor indicating the presence of a photographic film in the cassette holder (4) and/or by a switch in the cassette holder (4) and/or by a sensor indicating an orientation of the housing (10) for either digital or photographic X-ray imaging and/or by a manual switch and/or by means of software.
10. A digital X-ray scanning apparatus (1), in particular according to one of the previous claims, comprising an X-ray source (2), an X-ray collimator (3), an X-ray detector (14), mounting means (9-11) for mounting the X-ray detector (14), scanning means (12, 7) for scanning (8b, 27) the X-ray detector (14) over an area (5), means (16) for digital data acquisition from the X-ray detector (14) and a control unit (2c) for steering the X-ray apparatus (1), characterized in that the mounting means (9-11) are designed such that the X-ray detector (14) is held in a position shifted towards an anode side (2a) of the X-ray source (2) by an angle α , wherein $0^\circ < \alpha < \beta$ with β =anode angle.

11. The X-ray apparatus (1) according to claim 10, characterized in that
- a) the positioning angle α is chosen around $\beta/2$,
 - b) in particular that $4^\circ < \alpha < 12^\circ$, preferably $\alpha = 6^\circ$ with $\beta = 12^\circ$.
12. The X-ray apparatus (1) according to one of the previous claims, characterized in that the X-ray collimator (3) has an opening (3b) for photographic imaging and comprises at least one movable shutter (19a) with a built-in collimator slit (3a) to provide a precisely collimated beam (26a) for digital X-ray scanning.
13. The X-ray apparatus (1) according to claim 12, characterized in that
- a) the X-ray collimator (3) comprises two pivoted shutters (19a, 19b) and/or
 - b) the X-ray collimator (3) comprises a turning knob (18) to open or close a shutter (19a, 19b) and/or
 - c) a shutter (19a) has means (20) for adjusting a position of the slit (3a) and/or a width y of the slit (3a) in a range $0.2 \text{ mm} < y < 5 \text{ mm}$ and/or
 - d) the X-ray collimator slit (3a) is positioned in a fixed distance from the X-ray source (2).
14. The X-ray apparatus (1) according to one of the previous claims, characterized in that
- a) the X-ray detector (14) is a single- or multi-line X-ray detector (14) with X-ray sensitive elements and
 - b) in particular that the X-ray sensitive elements comprise scintillator crystals and optical detectors, that are connected to at least one A/D converter and to a microcomputer (16) for serial read-out.

15. The X-ray apparatus (1) according to claim 14, characterized in that the X-ray detector (14) has means for gain and/or offset correction of analogue signals from each X-ray sensitive element and/or from the whole detector (14).
16. The X-ray apparatus (1) according to one of the previous claims, characterized in that
- a) the X-ray detector (14) has a digital signal processor for detector control and data acquisition and/or
 - b) the X-ray detector (14) has a digital memory for data acquisition and data storage.
17. The X-ray apparatus (1) according to one of the previous claims, characterized in that for full or partial body digital X-ray imaging distance ranges $900 \text{ mm} < d_1 < 1450 \text{ mm}$, $500 \text{ mm} < d_2 < 900 \text{ mm}$ and $10 \text{ mm} < d_3 < 200 \text{ mm}$ are provided, where d_1 =distance between the X-ray source (2) and the X-ray detector (14), d_2 =distance between the X-ray collimator slit (3a) and the X-ray detector (14) and d_3 =distance between the patient (5) and the X-ray detector (14).
18. The X-ray apparatus (1) according to one of the previous claims, characterized in that
- a) a supporting arm (9) for carrying the X-ray source (2), the X-ray collimator (3) and a housing (10) for the detector (14) is provided and
 - b) the supporting arm (9) is rotatable and the X-ray source (2) together with the X-ray collimator (3) and the housing (10) for the detector (14) are tiltable with respect to the supporting arm (9) in order to position the X-ray source (2), the X-ray collimator (3) and the detector (14) for X-raying a standing, sitting or lying patient (5).

19. The X-ray apparatus (1) according to claim 18, characterized in that the X-ray source (2) and/or the housing (10) for the X-ray detector (14) are movable along the supporting arm (9) for selecting a distance d_1 between the X-ray source (2) and the X-ray detector (14) or, in particular, a photographic film in a cassette holder (4) contained in the housing (10).
20. The X-ray apparatus (1) according to one of the claims 18-19, characterized in that
- a) the supporting arm (9) has a suspension that is movable horizontally (27) for X-raying a lying patient and/or
 - b) the supporting arm (9) has a suspension that is movable vertically (27) for X-raying a standing or sitting patient and/or
 - c) the supporting arm (9) is rotatable by at least 90° in order to switch between X-raying a standing or sitting and a lying patient (5).

FIG. 1

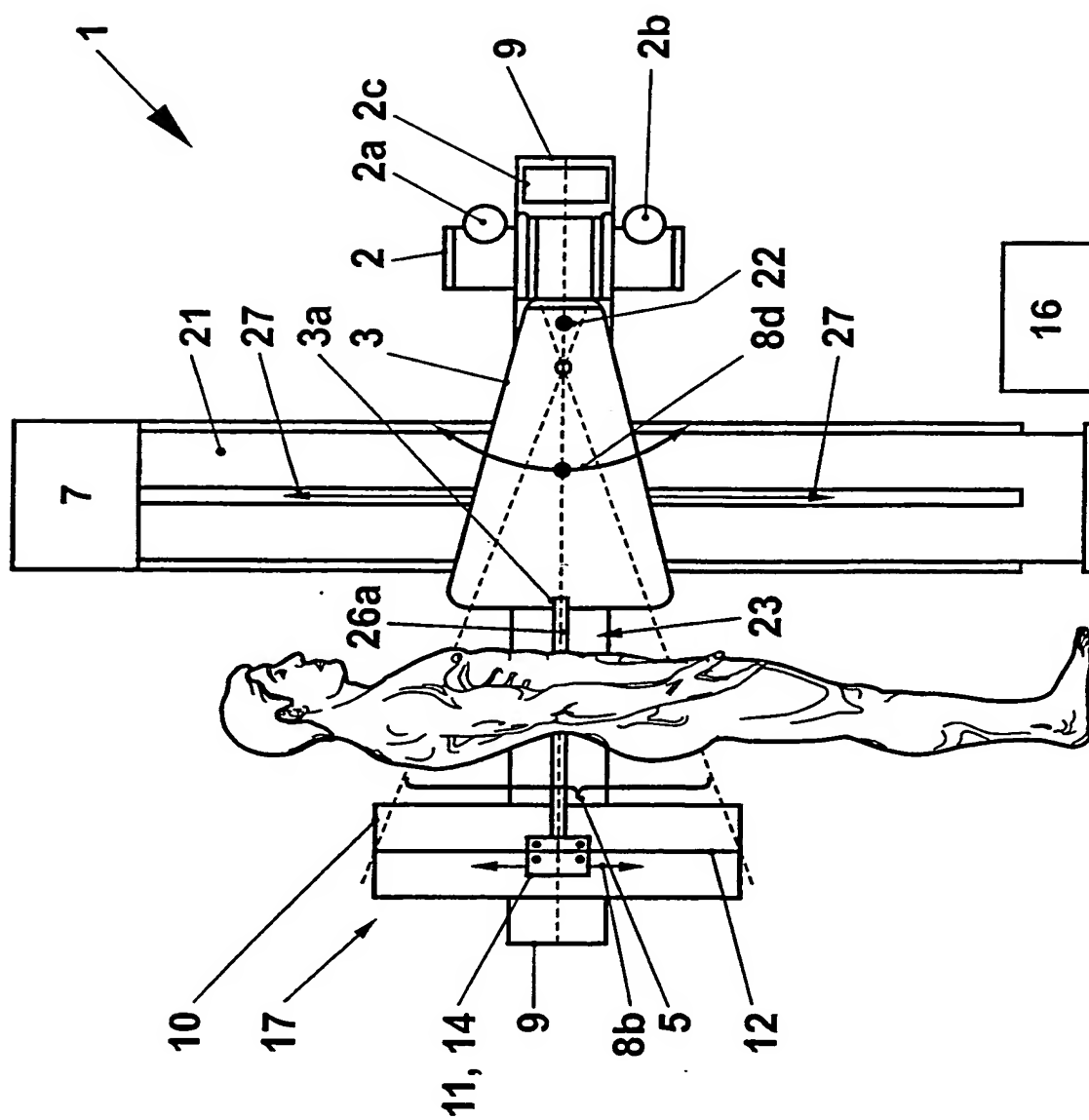
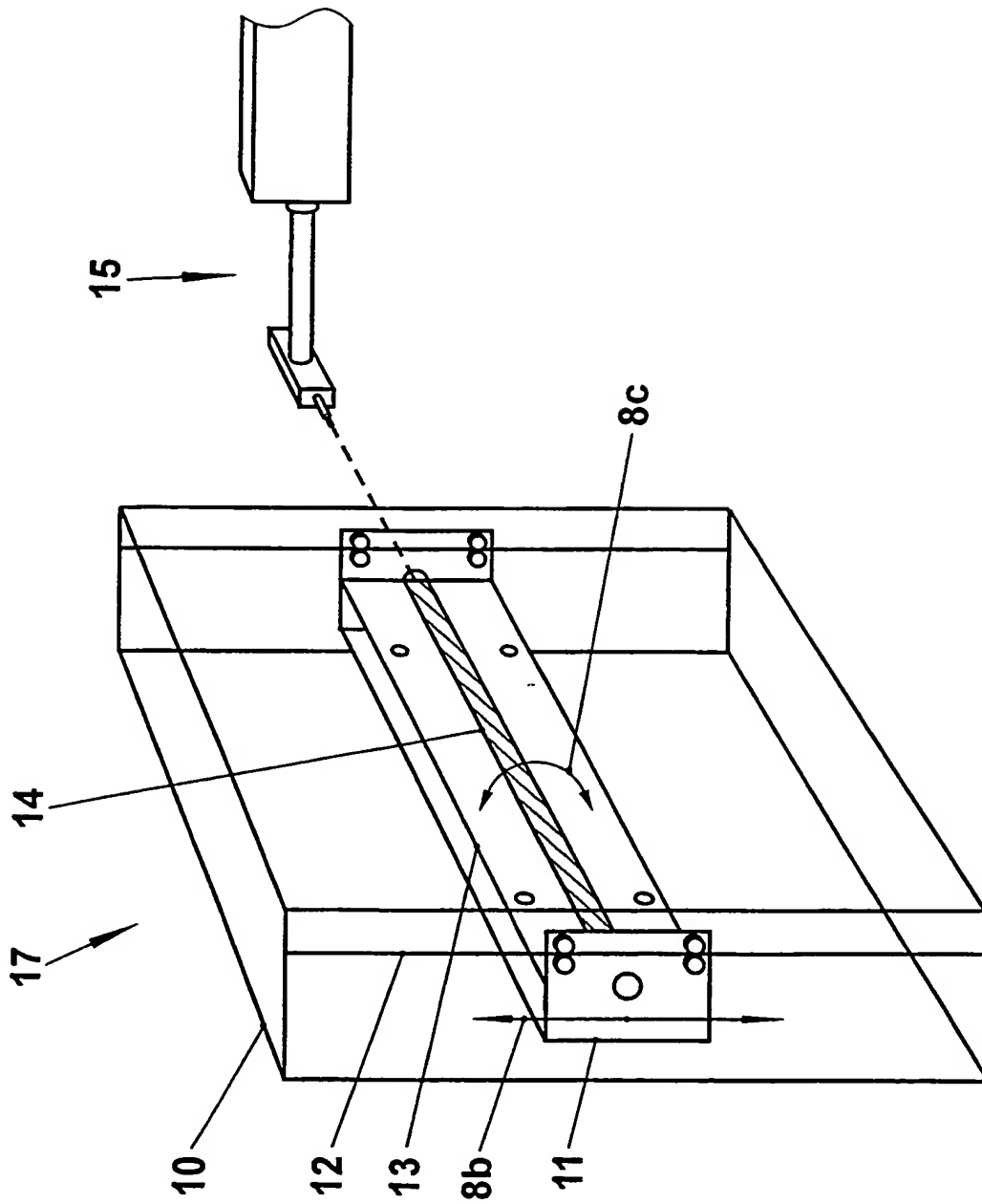


FIG. 2



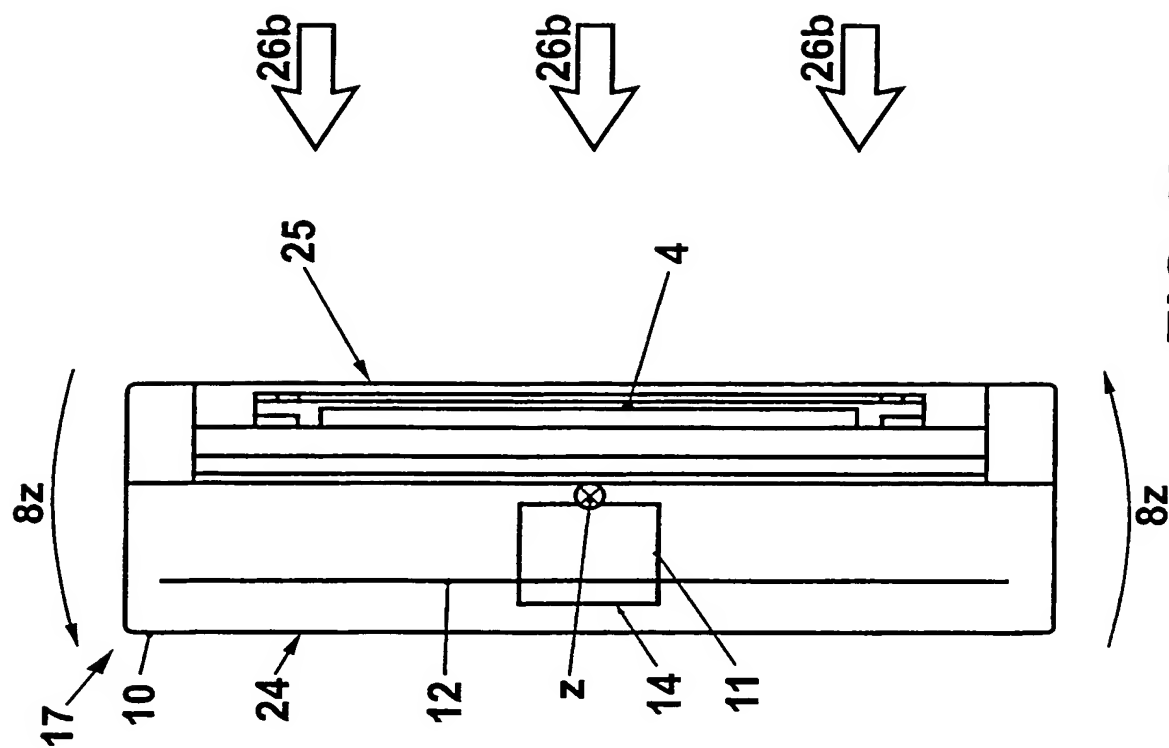
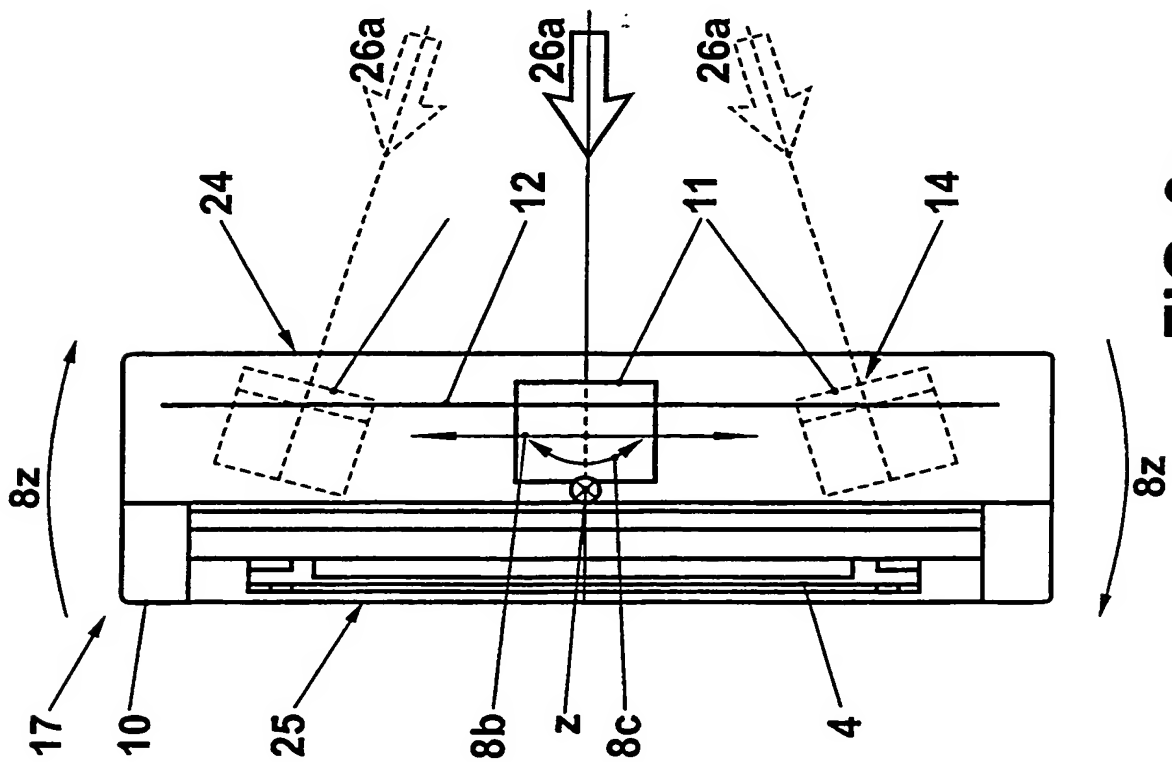


FIG. 3b



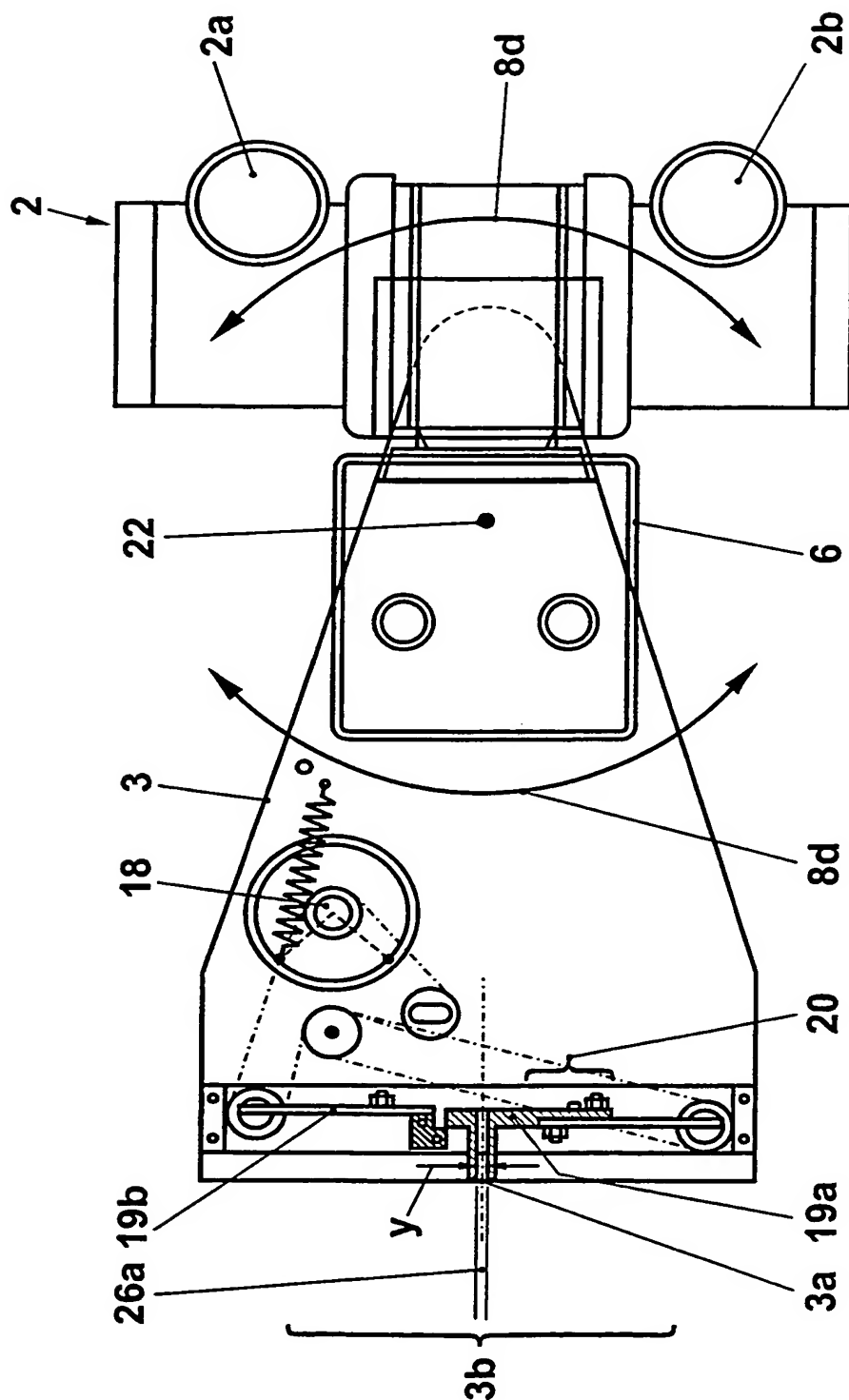


FIG. 4

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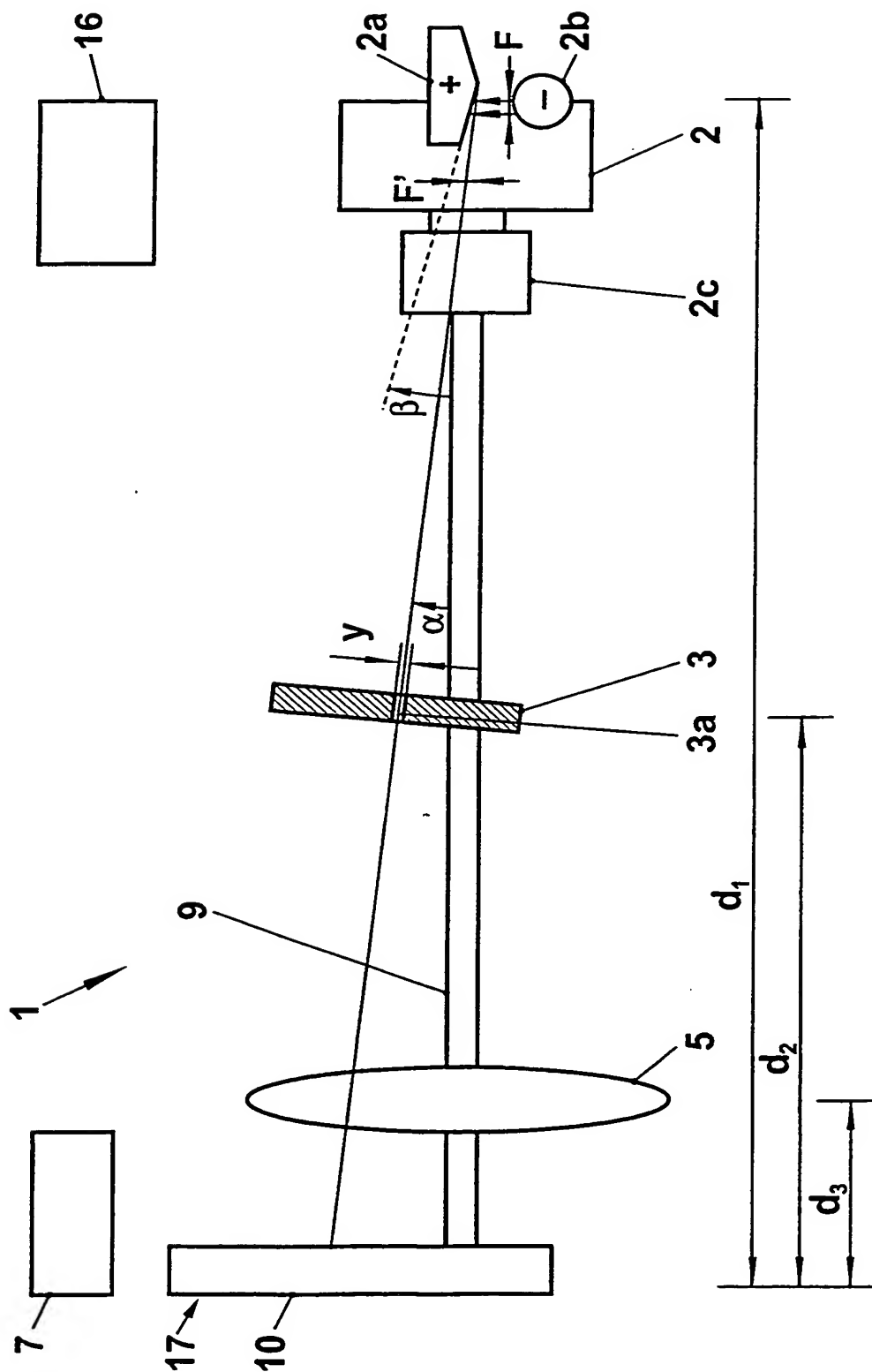
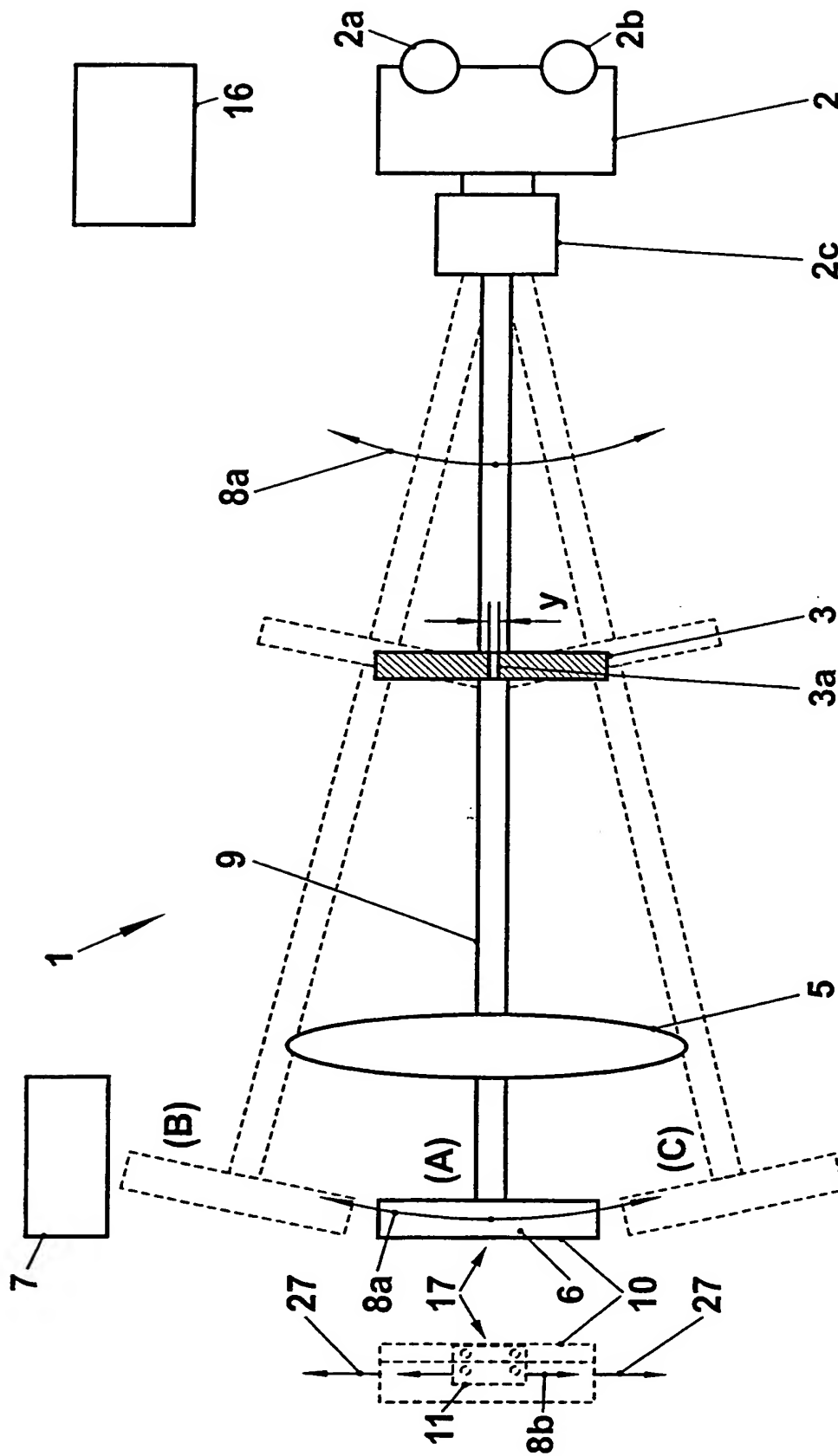


FIG. 5

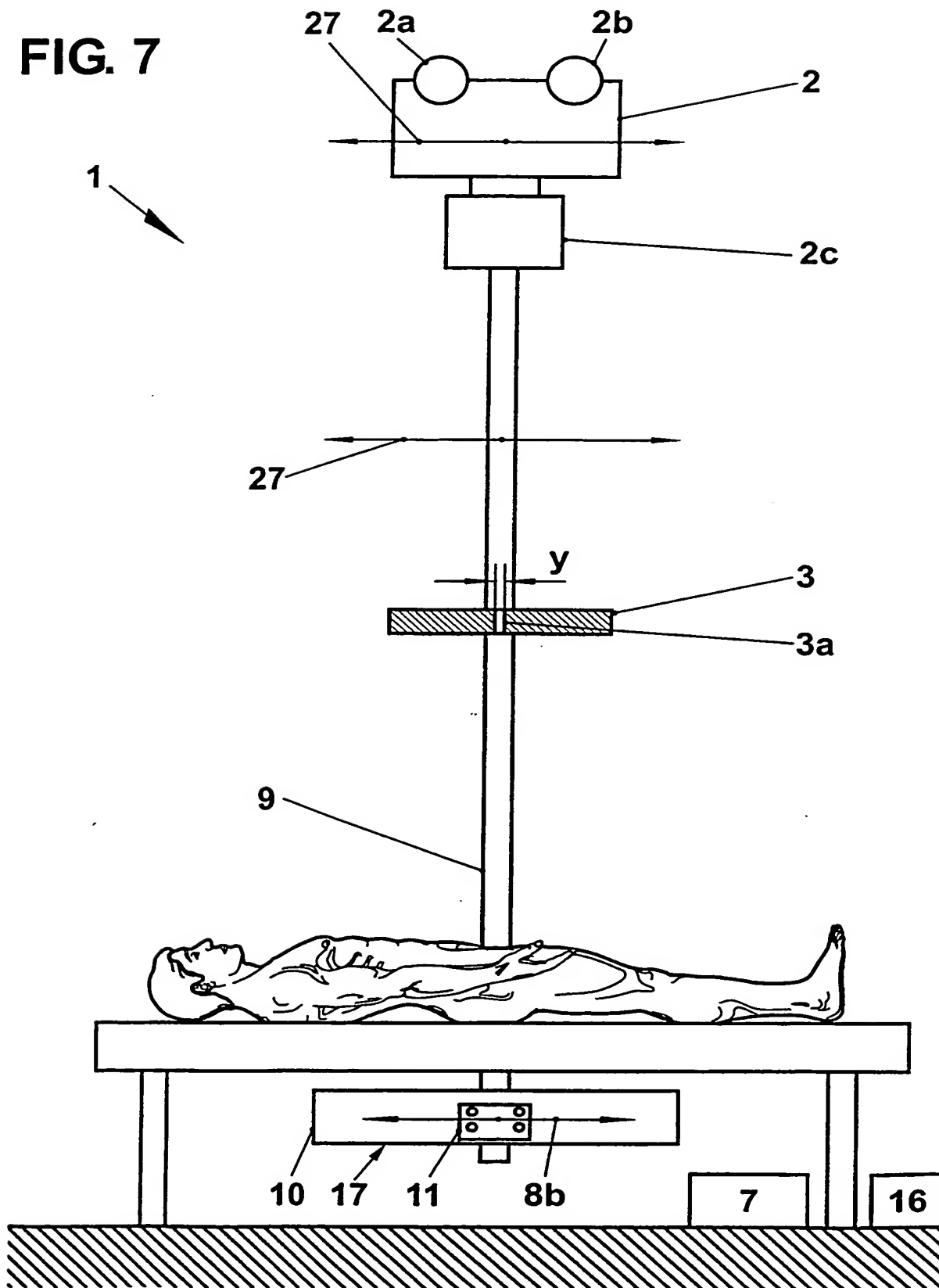
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FIG. 6



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FIG. 7



INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 00/00725

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A61B6/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

12 September 2000

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19/09/2000

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INTERNATIONAL SEARCH REPORT

Interr 1st Application No
PCT/IB 00/00725

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